

## **EFFECT OF MASTERING LEARNING INSTRUCTIONAL APPROACH ON RETENTION AND ATTITUDE OF SECONDARY SCHOOL STUDENT IN MATHEMATICS**

**Ihendinihu, Uchechi Ezinwanyi, PhD**

Department of Science Education,  
Michael Okpara University of Agriculture, Umudike.

### **Abstract:**

*The study investigated the effect of mastery learning instructional approach on retention and attitude of secondary school students in mathematics. Two research questions and two hypotheses guided the study. The design is a pre-test post-test non-equivalent control group in a quasi – experimental. A sample of 132 SSI students was selected from two government owned secondary schools in Umuahia education zone of Abia State. Data were collected using Mathematics achievement tests and mathematics attitude questionnaire validated by two mathematics educators and two lecturers from measurement and evaluation. The reliability indices of 0.85 and 0.91 were obtained for achievement tests and attitude questionnaire respectively by using Pearson Product Moment Correlation (PPMC) in test retest for achievement tests and Cronbach alpha for attitude questionnaire. Results of data analyses done using percentage mean score and Analysis of Covariance indicated significant difference in the retention and attitude of students in experimental and control groups in favour of the experimental group. The research recommends among others, adoption of mastery learning approach to the teaching of mathematics and other subjects; training for serving mathematics teachers and student teachers on the modalities for adopting mastery learning approach; a review of curriculum to accommodate the practice of mastery learning, and upward review of teachers remuneration to motivate them to cope with the demands of accommodating individual differences in learners, which mastery learning advocates.*

### **Introduction:**

The act of teaching among human beings predates the advent of formal education. Mkpa (2011) noted that man has always been concerned with how to impart knowledge and life skills to succeeding generations and has consciously or unconsciously sought out strategies for imparting knowledge and life skills. He further identified three perspectives of mastery required in teaching as a skill intensive activity. The first is knowledge of the learner. This is the psychology of the learner. The lecturer or teacher must have not just a

peripheral but a detailed knowledge of development of the learner, which encompasses even the learning process and how to take advantage of this Knowledge in instructional design, planning and delivery. Knowledge here must be deep. The second is Knowledge of the subject. This is the academic and intellectual appropriateness of the teacher. The teacher has to be a dependable source of knowledge over and above the knowledge or information of the learner. Hence mastery of the topic is required of the teacher. Lastly is Knowledge of the appropriate process of instruction. This is the teacher's ability to discern the level of students' consciousness of the topic, identify discrepancies between the students level of consciousness and what he ought to take away from the instructional interaction, and the skill to plan appropriate meaningful interactions with the students and of course, the skill to measure level of output.

The acquisition and employment of skills for teaching come from two dimensions or attributes of a teacher which, inevitably, must complement one another. These according to Mkpa (2011) are: training for the skills and repeated utilization of skills learned in training; improving teaching skills of teachers to embrace three important instructional delivery techniques. The first is taking interest in performing a needs assessment of the learner. This will involve taking time to identify the goals in order of importance, identifying the level of expected performance of students and their observed actual performance, and developing priorities for action (instruction). The second is taking interest in developing and writing performance objectives for every course taught. This involves developing interest in systematically organizing the course (instruction), and developing needs analysis for each course. The third is to determine the end – of – course objectives which not only guide the development of unit objectives but are measures of what the performance of students should be at the end of the course.

In curriculum development, courses are split into smaller units. Hence it is imperative to determine and clearly state the unit objectives. Developing adequate skills in assessing learner performance which would involve designing achievement tests in a manner that will assure the validity and reliability of such tests demands adequate mastery of content of subject matter. Sequel to this, it is imperative that the ability of and extent to which learner's master concepts taught by the teacher is largely dependent on the teachers knowledge of subject matter and approach to instruction. The above guidelines align with the principles of mastery learning.

Mastery learning as an instructional approach is based on the principle that all the students can learn a set of reasonable objectives with appropriate instruction and sufficient time to learn. Mastery learning approach is a group

based strategy for adopting instruction to the needs of individual learners. It takes care of individual students' characteristics as well as their aspirations. Mastery learning put the techniques of tutoring and individualized instructions into a group learning situation and brings the learning strategies of successful students to nearly all the students of a given group. It claims that the majority of learners in school have sufficient intellectual ability to master all the learning experiences presented by the teacher, provided the instructional strategy is learner centred. The students must reach a predetermined level of mastery on one unit before they are allowed to progress to the next. Hence, the students are not advanced to a subsequent learning objective until they demonstrate proficiency with the current one. Mastery learning approach reduces individual differences in learning, thereby destroying the myth surrounding the normal curve which holds that only a minor proportion of students should be able to learn what is to be taught (Ihendinihu, 2013). Therefore, rather than accepting the idea that differences in student aptitudes will lead to corresponding differences in student achievement, mastery learning theory holds that adequate or sufficient instructional time and resources should be used to bring all the students up to an accepted level of achievement. Students who do not satisfactorily complete a topic or learning task are given additional instruction with diverse methods and strategies until they succeed.

Mastery learning approach is at variance with the conventional traditional approach to instruction. The present practice mechanically applies the same instructional methods and allocates the same time to dull, average as well as bright children. This could be responsible for much of the ineffectiveness of instruction given in schools. In the classroom, instructions are prepared with the average student in focus. The above average or fast learners feel bored whereas slow learners or below average students remain passive and day by day, they become poor in the subject (Ihendinihu, 2015). Failure of large magnitude high drop out and stagnation rate and so on may occur because of accumulated learning deficit brought about by non – insistence on mastery of materials learnt at each of the earlier stages. Hence, there is need to explore the integration of mastery learning instructional approach in our school system as the instructional approach employed by the teachers can easily be manipulated to bring positive changes in learners. Researchers have reported that good instructional strategies are capable of improving the achievement of students in mathematics and other subjects (Iji, 2005; Mkpa and Ihendinihu, 2008; Ihendinihu 2015; Olunloye 2010).

Proponents of mastery learning are of the view that teachers should ensure that students master the concepts taught by employing many

mathematics enrichment programmes and allowing varying instructional time to students depending on their diverse aptitudes. Some scholars have reported that mastery learning approach to instruction is effective in enhancing the achievement of students in mathematics and other subjects (Adeyemi 2007; Samuel, 2007; Olufunmilayo, 2010; Akinsola, 2011; Kazu, Kazu & Ozdemir, 2005; Wambugu & Changeiywo, 2008; Abakpa & Iji, 2011). However, there seems to be paucity of research on the effect of mastery learning on retention and attitude of students in mathematics especially in Abia state – an area where this study was focused.

Retention may be defined as the ability to store facts and remember things easily. Purdy and Luepruti in Agommuoh (2010) noted that the ability to remember takes place more effectively when experiences are passed across to the learner through an appropriate instructional strategy. Retention is therefore a necessary factor for students to properly apply learnt concept. This implies that if there is no proper storage structures developed in the learner, information recalling may be marred and consequently resulting to poor performance. It is hoped that effective teaching strategy and insistence on mastery of concept will enhance retention. However in mathematics, it is suspected that students do not master mathematical concepts, formulae, rules and the relationship between various concepts properly. This no doubt will affect retention of learned materials and consequently cause poor achievement in the subject. Igbokwe in Ihendinihu (2015) and Ifeanacho (2012) reported that Mastery Learning enhances retention of Geography and Statistics concepts respectively. The researcher observed from literature that not much work has been done on mastery learning and retention in mathematics. In fact, the researcher is not aware of any researches on mastery learning models and retention of mathematics concepts, especially in Abia state. It is against this back drop that the researcher includes retention as a variable for study in this work.

Attitude towards mathematics denotes interest or feeling towards studying mathematics. It is the students' disposition towards 'like' or 'dislike' mathematics. According to Mkpa (2006:186) "an attitude is often defined as a tendency to react favorably or unfavorably towards a designed class of stimuli" It is generally believed that students attitude towards a subject determines their success in that subject. In other words, favourable attitude results to good performance in a subject. A student's constant failure in a school subject and mathematics in particular can make him to believe that he can never do well on the subject thus accepting defeat. On the other hand his successful experience can make him develop a positive attitude towards learning the subject. This suggests that students attitude towards mathematics

can be influenced by the teaching strategy or approach adopted. This is supported by Bolaji (2005) who reported that the teachers' method of teaching mathematics and his personality greatly accounted for the students' positive attitude towards mathematics. It has been observed that many students display negative attitude towards mathematics as a subject. In fact, many students see mathematics as a myth. Others see the subject as belonging to a select few. Hence mathematics phobia is prevalent among secondary school students.

Yara (2009) noted that without interest and personal effort in learning mathematics by the students, they can hardly perform well. Several studies have been carried out on students' attitude and academic achievement. For instance Akinsola and Olawajaije (2008) examined the effect of instructional strategies on students' attitudes towards mathematics in Lagos state. Based on the result of their analyses, they concluded that teachers' method of instruction in classroom is important in changing students' attitude and habits towards mathematics.

Furthermore, Schreiber (2000) and Uhumauvbi and Umorem (2005), in their own studies reported that positive attitude is conducive to good performance, that is, there exist strong positive correlation between attitude and achievement. However Ghanabarzedeh (2001) and Bayram (2004) have seen an individual's attitude towards a subject as weak predictor of his subsequent performance. Despite these diverse views and reports on attitude towards mathematics and students achievement, attempts have been made to improve students' attitudes and achievements. The conflicting results on the relationship between achievement and attitude of students towards mathematics creates the need for further investigation on the effect of mastery learning approach to instruction on students attitude towards mathematics.

Mathematics serves as a bedrock for other science subjects and at the same time strengthens and sharpens the intellectual skills of students Existing works by experts show mathematics as the pivot upon which all scientific and most non- scientific studies revolves. For instance, Uhumuavbi and Umoru (2005) stressed that mathematics plays an important role in national development such that any nation that is serious in its quest to develop its technology base must be serious in the teaching and learning of mathematics vis-à-vis its attainment by students. Hence mathematics could be seen as a servant to human beings and its prime place in the present scientific and technological world cannot be over-emphasized.

Obviously no nation can survive scientifically, technologically, socially, politically and economically without mathematics (Ihendinihu, 2017). In the business circle, one needs an acceptable aptitude in mathematics to

avoid pitfalls and mis-calculations that would result to business losses. Business transactions involve one form of calculations or the other and the level of sophistication in today's business world requires that a businessman of today needs to be fairly literate in mathematics. Mathematics is integral to everything about life, as every occupation which a student may choose to pursue and much of his or her daily life is full of opportunities that require application of Mathematics. In terms of curriculum relevance, mathematics is compulsory at the secondary school level and a pre-requisite for moving from the junior to the senior secondary school. At the tertiary level of education, a credit pass in mathematics is a necessary condition for the study of all science, technology and social science based courses as required by the Joint Admission and Matriculation Board. FRN (2013) asserted that mathematics equips pupils with a uniquely powerful set of tools to understand and change the world. These tools, they said, include: Logical reasoning, problem solving skills and the ability to think in abstract ways.

Mathematics is universal in the sense that other fields of human thought are not. It finds useful applications in business, industry, music, scholarship, politics, sports, medicine, agriculture engineering, and the social and natural sciences. Hence, the relationship between mathematics and the other fields of basic and applied science is especially Strong, (Ihendinihu, 2014). Mathematics relies on both logic and creativity and it is pursued for a variety of practical purposes and for its intrinsic interest. The abstract nature and relevance of mathematics calls for the need to adopt appropriate teaching methods/strategies/ approaches in its teaching to see if retention and attitude of students in Mathematics can be improved.

Two research questions and two hypothesis guided the study and they include:

1. What is the difference between the retention scores of students who used mastery learning and those who used conventional teaching approach?
2. What is the difference between the attitude to mathematics of students who used mastery learning and those who used conventional teaching approach

1: There is no significant difference in the retention scores of students who used mastery learning and those who used conventional teaching approach.

2: There is no significant difference in the attitude scores of students who used mastery learning and those who used conventional teaching approach.

**Method:**

The study adopted a quasi -experimental design involving a pre-test post- test. Specifically, it employed a non – equivalent control group design. Intact classes were used and treatment was randomly assigned to them. The duration of the study was 10 weeks and that justified the use of intact classes, so that normal programme will not be disrupted. The period of 10 weeks was also in order to accommodate 3 weeks delayed achievement test used for test of retention.

The subjects for this study were secondary school students in state owned schools in Abia state. A sample of 132 SS1 students was selected from two secondary schools using purposive sampling technique for school and simple random sampling for selecting two streams of SS1 from each school, for the study. Experimental and control groups were randomly assigned to the selected streams in each of the schools. The instruments used for data collection were Mathematics Achievement Test (MAT) made up of ten (10) essay questions and fifty (50) multiple choice questions and Mathematics Attitude Questionnaire (MAQ). Two specialists from Mathematics Education and two lecturers from Measurement and Evaluation validated the instruments. Cronbach alpha was used to determine the internal consistency of the MAQ and the multiple choice questions in MAT whereas test – retest using Pearson Product Moment Correlation and Kendall’s coefficient of concordance were used to establish the reliability of the MAT. The reliability coefficients of 0.84 and 0.79 were obtained for MAQ and MAT respectively.

The regular Mathematics teachers of the schools selected for the study were coordinated and trained as research assistants to assist in conducting the experiment. The researcher taught both the experimental and control groups whereas the research assistants assisted the mastery learning groups to achieve mastery. Although experimental and control groups were constituted in each of the two schools, during analyses, the scores of students from the experimental groups were collapsed as well as those of the control groups. The responses of the students on the attitude questionnaire, pre and post treatment were transformed into scores using the weights assigned to them. Data collected from the pre-test and post-test scores of the students in retention test (delayed achievement) and attitude tests were statistically analysed. The research questions were answered using mean and percentage gain score while the hypotheses were tested using Analysis of Covariance at 0.05 level of significance.

**Results:**

The findings of the study based on research questions and hypotheses are presented in tables.

Table 1: Percentage Retention Gain Scores of Experimental and Control Groups

<i>Group</i>	<i>Mean of pre-test</i>	<i>Mean of post test</i>	<i>Gain score</i>	<i>Percentage gain score</i>
Experimental	34.74	67.47	32.73	94%
Control	35.88	38.55	2.67	7.4%

The percentage gain score of mastery learning group is 94% whereas the percentage gain score of conventional group is 7.4%. This suggests that mastery learning group performed better than the conventional group.

**Table 2:** Analysis of Covariance of Retention of Experimental and Control Groups.

Source	Type III Sum of Squares	D f	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	52216.322 <sup>a</sup>	2	26108.161	475.789	.000	.881
Intercept	16274.561	1	16274.561	296.584	.000	.697
Retexpre	24608.133	1	24608.133	448.453	.000	.777
Group	29311.752	1	29311.752	534.170	.000	.805
Error	7078.671	129	54.873			
Total	430189.000	132				
Corrected Total	59294.992	131				

a. R Squared = .881 (Adjusted R Squared = .879)

From the table, the F-values of 534.170 is significant at 0.05 (since  $0.000 < 0.05$ ) level of significance. Therefore the null hypothesis is rejected. The conclusion is that the difference in the mean retention scores of mastery learning group and conventional group is statistically significant in favour of the mastery learning group.

**Table 3:** Percentage Attitude Gain Score of Experimental and Control Groups

Group	Mean of pre-test	Mean of post test	Gain score	% Gain score
ML	1.8495	3.5623	1.7128	92.6%
Control	1.7112	1.8345	0.1233	7.2%

The percentage attitude gain score of experimental group is greater than the percentage attitude gain score of the control group. This suggests that the attitude of mastery learning group to mathematics is positively affected more than that of the control group.

**Table 4:** Analysis of Covariance of Attitude of Experimental and Control Groups

Dependent Variable: attexpost

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	113.584 <sup>a</sup>	2	56.792	850.646	.000	.930
Intercept	24.303	1	24.303	364.017	.000	.738
attexpre	15.077	1	15.077	225.833	.000	.636
group	86.929	1	86.929	1302.051	.000	.910
Error	8.612	129	.067			
Total	1083.343	132				
Corrected Total	122.196	131				

a. R Squared = .930 (Adjusted R Squared = .928)

From the table, the F- value of 1302.051 is significant at 0.05 level of significance (since the significance level 0.000 is less than 0.05). Hence the null hypothesis is rejected. The implication is that the difference between the attitude scores of experimental and control groups is statistically significant. Hence mastery learning positively affected the attitude of students to mathematics.

### Discussions

The results of analyses to compare the effect of mastery learning on retention of mathematics are shown in tables 1 and 2. On table 2, result shows that there is significant difference in the mean retention scores of students in the experimental and control groups. Also, analysis on table 1 shows that the

percentage gain score of the mastery learning groups is greater than that of the control group. These results indicate that mastery learning approach to instruction helped students retain the concepts learnt more than the conventional approach to instruction.

These findings agree with the result of studies by Igbokwe in Ihendinihu (2015); Mbotto and Ogar (2004), Ogbonna (2007), Agomuoh (2010) and Ifeanacho (2012) who found teaching methods efficacious in enhancing students' retention in geography, physics, mathematics, and statistics. According to Mbotto and Ogar (2004), for a teaching strategy to foster retention, it should be anchored on the following:

1. Meaningfulness of materials
2. Logical presentation of materials
3. Provision of pleasing consequences
4. Revision
5. Feedbacks.

The retentive effect of mastery learning could be due to the fact that it adopts the above steps which lead to meaningful learning. The meaningfulness of the mode of presentation facilitated the encoding of learnt content into memory. The constant revision of previous and present concepts adopted by mastery learning is capable of causing overlearning which is found to cause remembering and improves retention. This is in line with Nwamuoh (2006) who stated that psychologists recommend over learning to achieve remembering.

The results also corroborates earlier findings by Adeyemi (2007), Akinsola (2011); Olufumilayo (2010), Samule (2007) Ihendinihu (2013), Ihendinihu & Mkpa (2015) who reported that mastery learning as an experimental treatment improved students' achievement in mathematics and other subjects. This findings is in line with a prior expectations. The inherent merit of mastery learning approach in ensuring proficiency on a unit of objective before progressing to the next level could be responsible to the effectiveness of mastery learning. Hence, the prerequisite to a topic is always mastered well before studying the topic. The procedure of obtaining feedback through testing and applying corrective through instruction and re-testing with other remediation is an added advantage of the approach. The students will no doubt be grounded in the principles, concepts and formulae involved in the topics. This no doubt will foster retention of the concepts learnt.

Analyses of the effect of mastery learning on attitude are presented in tables 3 and 4. Result from table 4 shows that significant difference exist in the mean attitude scores of the two learning groups. Analysis on table 3 shows

better attitude of experimental group than the control group in the test of attitude. These findings are in line with the results of studies by Akinsola and Olowajaije (2008) and Uhumavbi and Umoru (2005) whose results show that appropriate instructional strategies engender positive attitude of students to mathematics.

The finding of this study accords perfectly with a priori – expectation. It has always been suspected that students negative attitude to mathematics, that is, the prevalence of mathematics phobia could be as a result of constant failure in the subject. It is evident that failure of large magnitude, high dropout, stagnation rate and in fact negative attitude may occur due to accumulated learning deficits brought about by non – insistence on mastery of materials learnt at each of the earlier stages. Hence, the inherent advantage of mastery learning in taking care of individual differences in learning due to individual students’ characteristics as well as their aspirations and the insistence on mastery of materials could have aroused the interest of the students to the subject. This no doubt will lead to displaying positive attitude to mathematics as students will cherish mathematics teachers who will be patient with them. This learning approach is capable of demystifying mathematics and bringing it to the grip of all students. Students’ self-concept will surely be enhanced with the introduction of mastery learning.

### **Conclusion**

The following two major conclusions are drawn based on the results of the analyses of data in this study.

1. Mastery learning approach to instruction foster retention of mathematics content learnt better than the conventional approach.
2. Students attitude to mathematics are positively affected by the use of mastery learning approach as opposed to the use of conventional teaching approach.

These conclusions have educational implications for the teacher, educational planners / administrators, students, parents and other stakeholders. The study has exposed an instructional approach that is capable of fostering retention and positively affecting attitude of students in mathematics. Therefore, it is necessary to equip student teachers and serving teachers with current innovative teaching methods and strategies that are student centred which will enable them accommodate individual differences in learners to ensure that nearly all students attain mastery of mathematics content. This will no doubt improve the achievement, retention and attitude of students to mathematics. The result shows that every child is capable of learning

mathematics content. Hence parents/guardians and teachers should be patient with every child as regards the learning of mathematics. They should allow sufficient time to their wards depending on their aptitude

For students, the result of this study will motivate them to participate in class and strive patiently in order to attain mastery of mathematics content. By this, they will have confidence in themselves and their self-concept will be enhanced.

The result of this study will help educational planners to appreciate the fact that children come to the class with individual differences and thus learn at different rates. The curriculum should be fashioned in a manner to accommodate individual differences in the learners. There is need to incorporate in the teaching plans periods when slow learners will be given additional instruction and activities that will be used to keep the fast learners busy during such periods. Academic calendar could be planned in a way that students complete their course of study at different times depending on their intellectual ability and their rate of learning. Teachers should be well remunerated to motivate them to put in their best to accommodate individual differences in their learners to ensure that all attends mastery of content learnt.

### **Recommendations:**

Based on the findings and conclusions drawn, the study recommends as follows:

1. Review of curriculum to accommodate individual differences in learners.
2. In-service training for teachers to enlighten them on the need to adopt diverse teaching methods during instruction to accommodate learning needs of all students.
3. Adoption of mastery learning approach in the teaching and learning of mathematics in secondary schools.
4. Structuring of academic calendar so that children can graduate at different times according to their intellectual ability.
5. Upward review of teachers' remuneration to motivate them to cope with the demands of accommodating individual differences in learners which mastery learning advocates.

### **References**

Abakpa, B.O. & Iji, C.O. (2011). *Effect of mastery learning approach on senior secondary school students achievement in geometry*. Retrieved from [http://stanonline.org/journal/pdf/JSTAN-Abakpa & Iji.pdf](http://stanonline.org/journal/pdf/JSTAN-Abakpa%20&%20Iji.pdf).

- Adeyemi, B.A. (2007). Learning social studies through mastery approach. *Educational Research and Review* 2(4), 60-63. Retrieved from <http://www.academicjournals.org/ERR>.
- Agomuoh, P. C. (2010). *Effects of prior knowledge, exploration discussion dissatisfaction with prior knowledge and application (PEDDA) and the learning cycle (TLC) constructivist instructional models on students' conceptual change and retention in physics*. Unpublished PhD Thesis submitted to the Department of Science Education, University of Nigeria, Nsukka.
- Akinsola, M.K. (2011). *Mastery learning, cooperative mastery learning strategies and students' achievement in integrated science*. Retrieved from <http://scholar.google.com/scholar?q=mastery+learning+cooperative+mastery>.
- Akinsola, M.K. & Olowojaiye, F.B. (2008). Teacher instructional methods and student attitudes towards mathematics. *International Electronics Journal of Mathematics Education*. 3(1), 60-73.
- Amoo, S.A. & Rahman, M. A. (2004). Secondary school students' attitude to learning of mathematics in the world of information technology. In M.A.G. Akale (Ed.) *Proceedings of the Forty Fifth Annual Conference of Science Teachers' Association of Nigeria*. Ibadan: Heinemann. 175-181.
- Ashcraft, M.H.(2002). *Current directions in psychological science*. Retrieved from <http://www.blacksynergy.com/link/do;/10.1111/1467.8721.00196/abs>
- Awofala, A.O.A & Nneji, I.M (2012). *Effect of framing team assisted individualized instructional strategies on students' achievement in mathematics*. Retrieved from JSTAN Awofala. %20 Adeniyi, %20 Nneji & Love %20 2012.Pdf Adobe Reader.
- Bayranm, S. (2004). The effect of instruction with concrete models on eight grade students' geometry achievement and attitudes towards geometry. *A Thesis Submitted to the Graduate School of Natural and Applied Sciences of Middle East Technical University*.
- Federal Republic of Nigeria (2013). *National Policy on Education*. Lagos: NERDC Press.
- Galadima, I. (2003). Gender inequality in algebraic word problem solving performance amongst secondary school students of Sokoto: Zamfara State. *Nigeria Journal of Curriculum Studies*, 10(2) 457-460.
- Ghanbarzadeh, N. (2001). An investigation of the relationship between mathematics attitudes, self-efficacy beliefs and mathematics performance

- expectations of the 9<sup>th</sup> grade girl and boy students in Tehran, *M.A. Thesis, University of Tehran*
- Ibe, E. (2006). Breaking gender barriers on achievement in stme using hands-on, minds-on science. In U. Nzewi (Ed.) *Proceedings of the Forty Seven Annual Conference of Science Teachers' Association of Nigeria*. Ibadan: Heinemann. 211-214.
- Ifeanacho, A.O & Ifeanacho, E.C.(2015). Effects of the Kumou teaching strategy on junior secondary school students' interest in statistics. *Journal of agriculture and science education* 1(1): 239-248
- Ifeanacho, A.O. (2012). Effect of kumon teaching strategy on achievement, interest and retention of junior secondary school students in statistics. *Unpublished PhD Thesis submitted to the Department of Science Education, University of Nigeria, Nsukka*
- Ihendinihu, U.E & Mkp, ND (2015). Comparative effect of mastery learning models on achievement of secondary school students in mathematics in Abia state. *Journal of agricultural and science education* 1(1): 449-458
- Ihendinihu, U.E (2013). Enhancing mathematics achievement of secondary school students using mastery learning. *Journal of emerging trends in educational research and policy studies* 4(6): 848-854
- Ihendinihu, U. E. (2015) Effects of Personalised Group-based and Integrated Models of Mastery Learning on Achievement, Retention and Attitude of students in Mathematics in Abia state. *Unplished Ph D Thesis submitted to Abia state University Uturu.*
- Ihendinihu, U. E. (2016) Effect of GeoGebra on students' achievement in mathematics: A focus on coordinate geometry. *Journal of Theoretical and empirical studies in Education* 5(1) 237-246.
- Ihendinihu, U. E. (2018) *Effect of Mathematics Games on Attitude of secondary school students in mathematics. Journal of the Nigerian Academy of Education (JONAED)* 14(1) 225-238.
- Iji, C. O. (2005). Effect of logo and basic programming on the achievement and retention in geometry of junior secondary school students. *Journal of Mathematical Association of Nigeria.*
- Kanno, T. N. (2004). Gender education and human resource development. *Nigeria Journal of Curriculum Studies*, 11(1), 29-34.
- Kazu, I.Y., Kazu, H. & Ozdemir, O. (2005). The effects of mastery learning model on the success of the students who attended "usage of basic information technologies course" *Educational Technology and Society*, 8(4), 233-243.

- Mboto, F.A. & Ogar, N.E. (2004). The relative effectiveness of guided and expository laboratories on student's retention in physics concept. *International Journal for Research in Education*, 2(1, 2), 53-68.
- Mkpa, A. M. (2011). *Improving Teaching Skills in Nigerian Tertiary Institutions*. In Uchendu, Emetaram and Okeke (eds.) Higher Education and Nigerian National Development. Owerri: Barloz Publishers.
- Mkpa, N.D. (2006). *Personality assessment: concepts, issues and theories*. Owerri; Vantage Press.
- Mkpa, N.D. & Ihendinihu, U. E. (2009). Effect of gender and schooltype on the effectiveness of guided scoring instructional strategy. *A paper presented at the third Annual National Conference of Female Teachers, at Umuahia on 10<sup>th</sup>-14<sup>th</sup> August 2009*
- Nnachi, R.O. (2003). *An introduction to psychology in education*. Okigwe: whytem prints
- Ogbonna, C.C (2007). A comparative study of the effectiveness of two constructivist instructional model on students' academic achievement and retention in JSS mathematics. *Unpublished PhD thesis, university of Nigeria. Nsukka*.
- Ogukunle, A.R. (2006). Reviewing the current state of resource for teaching of mathematics in schools. In U. Nzewi (Ed.) *Proceeding of the Forty Seventh Annual conference of Science Teachers' Association of Nigeria*, (pp 265-267), Ibadan: Heinemann.
- Olufunmilayo, I.O. (2010). Enhanced mastery learning strategy on the achievement and self-concept in senior secondary school chemistry. *Humanity and Social Science Journal* 5(1): 19-24.
- Olunloye, O. (2010). *Mass failure in mathematics: a national disaster*. Tribune of 07/02/2010 retrieved from <http://www.tribune.com.nig> on 08/05/2011
- Salau M. O. (2001). Comparative effects of attending single-sex and co-educational secondary schools on the female students' achievement in mathematics. In O.O. Busari (E.d) *Proceeding of the Forty Second Annual Conference of Science Teachers Association of Nigeria*, Ibadan: Heinemann. 299-303
- Samuel, O.S. (2007). Effects of personalized system of instruction on students' academic achievement in chemistry. *Pakistan journal of social science* 4 (1): pp 132-136.
- Schreiber, J.B. (2000). Advanced mathematics achievement: a hierarchical linear model, *PhD Dissertation, Indiana University*. Retrieved from [www.lib.umi.com/dissertations /results](http://www.lib.umi.com/dissertations/results) on 27/6/2011.

- Uhumuavbi, P.O. & Umoru, G.E. (2005). Relationship between interest in mathematics and science among polytechnic students - a case study of auchi polytechnic. *Nigerian Journal of Professional Teacher 1 (1)*, 71-76.
- Wambugu, P. W. & Changeiywo, J. M. (2008). Effects of mastery learning approaches on secondary school students' physics achievement. *Eurusia Journal of mathematics, Science and Technology education*, 4(3), 293-302.